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Effect of Fermentation on the Quality and Physicochemical Properties of Cassava Based Fu fu Products Made from Two Cassava Varieties NR8212 and Nwangbisi

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Abstract: Matured tubers from two cassava varieties NR8212 and Nwangbisi were fermented for 0-7 days respectively before processing into fufu. Physco-chemical analyses of the products were carried out to determine the effect of fermentation on the quality of the processed products. Results showed that the moisture content, pH, Titratable acidity and Cyanide values of the fufu samples ranged between 6.81-7.10; 4.03-6.37; 0.15-0.56% and 2.00-36.67 mg kg^{-1} HCN. It could be noted from this experiment that fermenting the cassava for 2 days optimally reduced the cyanide in fufu to 18.27 mg kg^{-1} HCN for Nwangbisi and 19.06 mg kg^{-1} HCN for NR8212. These values fall below the 20.00 mg kg^{-1} HCN recognized by standard organization of Nigeria as safe level. The kinetics of the degradation of the cassava cyanide also showed that the fermentation of the 2 varieties of cassava followed the first order Kinetic model. Thus a 1% increase in fermentation time (day) brings about 0.0696 decrease in HCN for the local variety (Nwangbisi) whereas a 1% increase in fermentation time (day) brings about 0.098 decrease in HCN for the improved variety (NR8212).

Key words: Cassava, fufu, hydrogen cyanide, physicochemical, properties

INTRODUCTION

Cassava, (*Manihot esculenta* crantz) is a root tuber produced in the tropical region of the world between latitudes 30° North and 30° South of the equator usually referred to as the cassava belt. In 1993, Nigeria was ranked the highest producer of cassava in the world. By 1996, Nigeria produced about 33 million metric tones of cassava (FAO, 1996), this achievement has been attributed to improved high yielding, pest and disease resistance cassava varieties produced and released to farmers (Ikwelle *et al*., 2003). Over 95% of cassava produced in Nigeria is used as foods for humans for whom roots are the major sources of dietary calories. Two major factors tend to limit the utilization of cassava in the form of the unprocessed tuber. The first is that the unprocessed tuber has relatively high amounts of toxic prussic acid, linamarin and lotaustralin. The second factor is that the fresh cassava tuber, unlike yam, cannot be stored for more than a few days after harvesting. After harvest, a day or two, the roots begin to deteriorate rapidly. They develop a bluish discolouration of the vascular bundles of the tuber, a symptom sometimes referred to as vascular streaking. In addition, the quality of starch in the tubers also deteriorates during storage.

Cyanogens or cyanogenic glycosides are glycosides (compounds containing a sugar moiety linked to a non-glycon entity from which it can be separated by hydrolysis) whose hydrolyses result in the release of toxic hydrocyanic acids. Glycosides are not themselves harmful but when hydrolysed by enzyme or other means release toxic hydrocyanic acid. Cassava contains the cyanogenic glucoside, linamarin and lotaustralin. The linamarin can be hydrolysed by the enzyme linamarase to release toxic hydrocynic acid or free hydrogen cyanide. Linamarin being present in quantity up to 90% of the total (Onimawo and Egbekun, 1988). Cyanide toxicity can equally lead to diseases such as Leber's Optical Atrophy, Tropical Ataxic Neuropathy, Endemic goiter and cretinism, Tropical Calcifying Pancreatitis and in some cases instant death. Cyanide is exceedingly toxic to man and domestic animals if consumed in amounts in excess of 25-30 ppm (Onimawo and Egbekun, 1988). Cassava roots must therefore be detoxified and the liberated cyanide subsequently eliminated before consumption. The hydrogen cyanide can readily be volatilized by heat or leached by soaking and washing. This characteristics of hydrocyanic acid forms the basis for the current method recommended for detoxification of cassava in cassava based foods such as 'gari', 'fufu' and 'abacha' (Okaka and Okaka, 2001).

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Cassava fufu (akpu) is made by fermenting freshly harvested cassava tubers in water in open containers for days. Fufu produced from cassava which has not been allowed enough fermentation time may contain high levels of bound cyanide after drying. The objective of this experiment is to evaluate the effect of fermentation on cynide content of fufu. This study, to determine the safe processing level became necessary as the fermentation time in the processing of this product has been observed to be drastically shortened to as low as 6 h for quick economic returns.

MATERIALS AND METHODS

Freshly harvested cassava roots of improved variety NR8212 obtained from National Root Crops Research Institute, Umudike, Abia state, Nigeria and local variety (Nwangbisi) from a village farm in Umudike were fermented for a period of 0-7 days before processing into fufu.

Processing of fufu: Fufu was processed from cassava roots of both varieties fermented for 0-7days as described by (Oji 1983; Ejiofor, 1997). In the fufu processing, 10 kg cassava roots were peeled, washed and steeped in water for (0-7days) to soften and ferment the pulp. The fermented mash was washed in clean water and grated and then re-steeped in water for 24 h, de-watered, sieved (2 mm sieve), oven dried for 40 h at temperature 0f 60°C to a moisture content of about 7%. The dried mash was milled into flour to get odourless fufu flour.

Chemical analysis: Analysis such as moisture content, cyanide content, acidity (as lactic acid) and pH were carried out to determine the quality of the processed products and the effect of the process treatment on the cyanide content of the cassava products (fufu).

Moisture content determination: Moisture content was determined according to AOAC (1990) method.

pH determination: The pH of the fufu samples was determined using a calibrated pH 211 microporcessor pH meter. One gramme of each fufu flour samples were dispersed in distilled water to make up to 10 mL. The dispersion was allowed to stand for 30 min. The electrode was immersed into the dispersion and then shaken and allowed to stand till a stable reading was gotten. The value was recorded. This was repeated to get duplicated reading.

Total titratable acidity: The method of Sadler and Murphy (2003) was used. Three grammes each of fufu flour samples were weighed into a conical flask. Then 30 mL distilled water was added and allowed to stand for 30 min. Phenolphthalein indicator (3 drops of) was added to the dispersion. The dispersion was then titrated with a standard base (0.1N NaOH) to a phenolphthalein end point. The volume of the titrant used along with the normality of the base and the weight of sample were used to calculate the titratable acidity expressed as lactic acid using the formula,

$$\% \text{ acid } ({}^{wt}/_{wt}) = \frac{N \times V \times Eq\ wt}{W \times 1000} \times \frac{100}{1}$$

Where,
N = Normality of titrant (mEg mL^{-1})
V = Volume of titrant (mL)
Eqwt = Equivalent weight of predominant acid (mg mEq^{-1})
1000 = Factor relating mg to grams (mg g^{-1})

Hydrogen cyanide determination: The determination of the Hydrogen Cyanide (HCN) in the samples was done using the alkaline picrate method of Wang and filled as described by Onwuka (2005). Two grammes of each sample was made into a paste in 20 mL of distilled water in a corked conical flask overnight after which extraction took place. The extract was filtered and the filtrate used in the analysis. To 1 mL of the filtrate in a test tube, 4 mL of alkaline picrate solution was added and the test tube incubated in a water bath at 90°C for 5 min. After colour development, the absorbance values of each sample was determined at 490nm using a spectrophotometer. The cyanide level was then extrapolated from a cyanide standard curve. A blank reagent was prepared by measuring 4 mL of alkaline picrate in 1 mL of distilled water. The blank was used to standardize the spectrophotometer before taking the absorbance of the samples.

Statistical analysis: The data generated were subjected to Statistical analysis using Analysis of Variance (ANOVA) and the means separated using the Fishers' Least Significant Difference (LSD) according to Snedecor (1956).

RESULTS AND DISCUSSION

Physico-chemical properties of the fufu sample: The cyanogenic content of the raw cassava roots from the two different varieties are given in Table 1. Variety NR8212 had approximately 171 ppm while Nwangbisi had 190 ppm hydrogen cyanide. The values are quite high and if taken in their native state will definitely cause harm as save level is as low as 20 ppm (Almazan,1992).

Table 1: Hydrogen Cyanide content of raw cassava roots from 2 different cassava varieties (mg kg^{-1} HCN)

Variety	Cyanide content (mg kg^{-1} HCN) Raw roots
NR 8212	170.9±2.41
Nwangbisi	189.6±1.73

*Means of 3 determinations±S.D

Table 2: Mean values of physico-chemical properties of fufu flour from a Local cassava variety (*Nwangbisi*) as affected by fermentation

Fermentation period (days)	Physico-chemical properties: Moisture (%)	pH	Titratable acidity (% wt/wt)	Cyanide mg kg^{-1} HCN
0	7.05^{abc}±0.05	6.37^{a}±0.03	0.48^{a}±0.00	36.67^{a}±1.15
1	7.02^{abcd}±0.13	6.13^{b}±0.03	0.44^{b}±0.02	22.50^{b}±0.50
2	6.97^{bcd}±0.03	6.08^{b}±0.08	0.41^{c}±0.02	18.27^{c}±0.25
3	7.12^{a}±0.07	6.01^{c}±0.01	0.38^{d}±0.02	16.17^{d}±0.29
4	7.06^{ab}±0.08	5.96^{c}±0.02	0.41^{c}±0.02	15.97^{de}±0.06
5	6.92^{cd}±0.08	5.87^{d}±0.03	0.36^{d}±0.00	15.15^{e}±0.00
6	7.10^{ab}±0.06	5.85^{d}±0.01	0.37^{d}±0.02	8.13^{f}±0.23
7	6.91^{d}±0.10	5.75^{e}±0.05	0.32^{e}±0.02	2.00^{g}±0.05

* Means with different superscript within the same column are significantly different ($p<0.05$)

Table 3: Mean values of physico-chemical properties of fufu flour from an Improved cassava variety (NR 8212) as affected by fermentation (days)

Fermentation period (days)	Physico-chemical properties: Moisture (%)	pH	Titratable acidity (% wt/wt)	Cyanide mg kg^{-1} HCN
0	7.05^{a}±0.13	5.09^{e}±0.02	0.26^{d}±0.02	31.93^{a}±0.12
1	6.85^{cd}±0.07	4.03^{e}±0.03	0.56^{a}±0.02	22.10^{b}±0.66
2	6.87^{cd}±0.12	4.12^{e}±0.02	0.50^{b}±0.02	19.06^{c}±0.12
3	6.81^{d}±0.06	4.58^{d}±0.05	0.32^{c}±0.02	11.97^{d}±0.35
4	7.02^{ab}±0.03	5.49^{b}±0.04	0.23^{e}±0.02	10.23^{e}±0.32
5	7.05^{a}±0.05	5.93^{a}±0.03	0.33^{c}±0.00	8.37^{f}±0.35
6	6.90^{bcd}±0.08	5.32^{b}±0.02	0.15^{f}±0.00	7.53^{g}±0.25
7	6.97^{abc}±0.007	4.68^{d}±0.32	0.24^{ed}±0.00	4.14^{h}±0.23

* Means with different superscript within the same column are significantly different at ($p<0.05$).

The results of the analysis of the fufu samples from the two varieties (*NR8212* and *Nwangbisi*) are shown in (Table 2 and 3). An average moisture content of 6.5% was recorded which indicated that drying was adequate in removing moisture in fufu flour samples (Achinewhu, 1997). The pH, Titratable acidity and cyanide values of the fufu flour samples ranged between 5.75-6.37; 0.3-0.48%; 2.00-36.67 mg kg^{-1} HCN respectively for *Nwangbisi* variety and 4.03-5.93; 0.15-0.56% and 4.14-31.93 mg kg^{-1} HCN, respectively for NR8212 variety.

It will be observed from the experiment that the pH maintained a steady drop as the fermentation period increased indicative of increasing acidity. This is obviously expected as more fermentative organic metabolites are generated (Akingbala *et al*., 1991). The result is in agreement with earlier research of Idowu and Akindele.

During fermentation in the production of the fufu, retting of the cassava was observed which was probably due to the presence of microbial retting enzymes such as amylases and pectin-methyl esterases (Oyewole, 1991) with the resultant production of organic acids. The cyanide level decreased equally in both varieties as the fermentation days increased. However, fufu attained a safe cyanide level after 2 days fermentation that is 18.27 mg kg^{-1} HCN for Nwagbisi (Table 2) and 19.06 mg kg^{-1} HCN for NR8212 (Table 3) and this agrees with the view that soaking coupled with fermentation is more effective than fermentation alone. This research therefore has shown that fermenting cassava for two or more days is sufficient to detoxify the cyanide level of cassava in the production of fufu. The Standard Organization of Nigeria (SON) had earlier recommended cassava cyanide safe level to be 20 ppm (Almazan, 1992).

The decrease in cyanide is in agreement with the findings of Ejiofor and Chukwu (1997). Ejiofor and Chukwu (1997) particularly reported that Much of the cyanide resulting from hydrolysis of the glycosides was removed during fermentation, washing, soaking, dewatering and drying.

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